Activity monitoring

The present invention relates to activity monitoring, and in particular, but not exclusively to, activity monitoring of a human being.

The physical activity of a human being is an important determinant of its health. The amount of daily physical activity is considered to be a central factor in the etiology, prevention and treatment of various diseases. Information about personal physical activity can assist the individual in maintaining or improving his or her functional health status and quality of life.

A known system for monitoring human activity is described in the article "A Triaxial Accelerometer and Portable Data Processing Unit for the Assessment of Daily Physical Activity", by Bouten et al., IEEE Transactions on Biomedical Engineering, Vol. 44, N0.3, March 1997.

According to the known system a triaxial accelerometer composed of three orthogonally mounted uniaxial piezoresistive accelerometers is used to measure accelerations covering the amplitude and frequency ranges of human body acceleration. An individual wears the triaxial accelerometer over a certain period of time. A data processing unit is attached to the triaxial accelerometer and programmed to determine the time integrals of the moduli of accelerometer output from the three orthogonal measurement directions. These time integrals are summed up and the output is stored in a memory that can be read out by a computer. The output of the triaxial accelerometer bears some relation to energy expenditure due to physical activity and provides as such a measure for the latter.

The known system allows for measurement of human body acceleration in three directions. Using state of the art techniques in the field of integrated circuit technology the accelerometer can be built small and lightweight allowing it to be worn for several days or even longer without imposing a burden to the individual wearing it.

The known systems continuously sample and monitor information from the three accelerometers using three sample analog channels. Since the measurement is carried out continuously, the power consumption of such a device is undesirably high, and so it is

desirable to reduce power consumption, which should enable cheaper and/or smaller batteries to be usable.

It is therefore desirable to provide an activity monitor that can overcome these disadvantages.

According to one aspect of the present invention, there is provided an activity monitor comprising a measurement unit including a plurality of motion sensors, operable to produce respective sensor signals indicative of motion experienced thereby and a processor for receiving the sensor signals from the measurement unit and operable to process the signals in accordance with a predetermined method, characterised in that the measurement unit has a single output channel and is operable to output the sensor signals in turn on the output channel.

Fig. 1 shows a block diagram schematically showing the components of a system embodying one aspect of the present invention;

Fig. 2 schematically shows the orthogonal outputs of three accelerometers;

Fig. 3 shows a flow diagram of the steps of a method embodying another aspect of the present invention; and

Fig. 4 illustrates monitoring of sensor signals in embodiments of the present invention.

Figure 1 illustrates an activity monitor 1 embodying one aspect of the present invention. The activity monitor 1 comprises a measurement unit 11, a processor 12, and a memory unit 13. The measurement unit 11 is operable to produce data signals indicative of the motion of the activity monitor 1, and to supply those data signals to the processor 12. The processor 12 is operable to process the data signals output from the measurement unit, and is able to store the data signals, or the results of the processing in the memory unit 13. Data can be transferred between the processor and the memory unit 13. The processor 12 is also able to be connected to an external hose system 2, which can be a personal computer (PC) or other appropriate systems. The external hose system 2 can be used to perform additional processing of the data held in the activity monitor 1.

In use, the activity monitor 1 is attached to the object to be monitored. For purposes of illustration in the following it is assumed that the object is a human individual, although it is clearly possible to apply such an activity monitor for any object. The activity monitor is attached to the individual or object for a certain time period.

The measurement unit comprises three accelerometers which are arranged in mutually orthogonal directions. The accelerometers output data signals which are indicative of the respective accelerations experienced by the accelerometers. The three accelerometers are arranged orthogonal to one another in a conventional manner.

On an individual, these directions are formed "antero-posterior", "medio-lateral" and "vertical", that are denoted as x, y and z, respectively. The accelerometers comprise strips of piezo-electric material that is uni-axial and serial bimorph. The strips are fixed at one end thereof.

The piezo-electric accelerometers act as damped mass-spring systems, wherein the piezo-electric strips act as spring and damper. Movements of the strips due to movement of the individual generate an electric charge leading to a measurement of a data signal. In case of human movements the frequency of the data signals lies in the range of 0.1- 20 Hz. The amplitude of the data signals lies between –12 g and +12 g. These numbers are discussed in more detail in the article mentioned earlier. Suitable piezo-electric materials to measure such data signals are known to a person skilled in the art.

In accordance with the present invention, the measurement unit has a single output channel, preferably a single analog output channel, which is supplied to the processor 12. The measurement unit operates to output one of the accelerometer signals at any one time via the output channel. The accelerometer signals are output in turn to the output channel via the measurement unit.

In one preferred embodiment of the present invention, the processor is operable to sample the output channel measurement unit in discontinuous fashion. In such a case, the processor samples the output channel from the measurement unit for a predetermined amount of time, and then stops sampling the measurement unit.

In addition to the processor unit operating discontinuously, or as an alternative to that methodology, the measurement unit can operate the output channel discontinuously during the output of each accelerometer signal. Figure 3 is a flow diagram illustrating the cycled outputs of the measurement unit. As will be appreciated from Figure 3, each of the outputs a_x, a_y and a_z are output in turn from the measurement unit. This is further illustrated in

Figure 4. For the sake of clarity, no particular output signal is shown in Figure 4, but the time periods during which the respective accelerometer signals are output are shown.

It will be appreciated that reducing the number of channels required from the output of the measurement unit to the processor, can reduce the cost of the activity monitor overall. In addition, varying the sampling rate of the processor means that there are periods of time in which the processor is not active, and so battery power can be conserved during these times. Embodiments of the invention, therefore, can reduce the cost and/or battery power consumption of an activity monitor.

It will be readily appreciated that the accelerometers are merely preferred motion sensors, and that any appropriate motion sensor could be used in an embodiment of the present invention and achieve the advantages of the present invention.

It is emphasised that the term "comprises" or "comprising" is used in this specification to specify the presence of stated features, integers, steps or components, but does not preclude the addition of one or more further features, integers, steps or components, or groups thereof.